



# CoCo Seminar Series

## Spring 2024

### Structural Balance and Random Walks on Complex Networks with Complex Weights

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**Wednesday February 28, 2024 12:00-1:00pm EST**

**[Online]** (Zoom meeting link available on

<http://coco.binghamton.edu/>)



Complex numbers define the relationship between entities in many situations. A canonical example would be the off-diagonal terms in a Hamiltonian matrix in quantum physics. Recent years have seen an increasing interest to extend the tools of network science when the weight of edges are complex numbers. Here, we focus on the case when the weight matrix is Hermitian, a reasonable assumption in many applications, and investigate both structural and dynamical properties of the complex-weighted networks. Building on concepts from signed graphs, we introduce a classification of complex-weighted networks based on the notion of structural balance, and illustrate the shared spectral properties within each type. We then apply the results to characterise the dynamics of random walks on complex-weighted networks, where local consensus can be achieved asymptotically when the graph is structurally balanced, while global consensus will be obtained when it is strictly unbalanced. Finally, we explore potential applications of our findings by generalising the notion of cut, and propose an associated spectral clustering algorithm. We also provide further characteristics of the magnetic Laplacian, associating directed networks to complex-weighted ones. The performance of the algorithm is verified on both synthetic and real networks.

Dr. Yu Tian is a research fellow at Nordita, funded by Wallenberg Initiative on Networks and Quantum Information. Yu's research involves various aspects of network science, including dynamics and optimisation, incorporating negative signs (e.g., friend and foe relationship) and complex weights, and community detection. Before this, Yu received her PhD from University of Oxford, where she was supervised by Prof. Renaud Lambiotte and also in collaboration with Tesco Data Science Team.

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